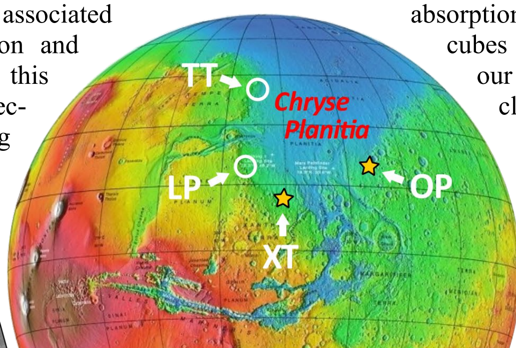
IN-DEPTH SPECTRAL ANALYSIS OF CLAY-BEARING OUTCROPS IN WEST CIRCUM-CHRYSE PLANITIA, MARS: LUNAE PLANUM AND TEMPE TERRA. J. Brossier*, F. Altieri, M.C. De Sanctis, A. Frigeri, M. Ferrari, S. De Angelis, A. Apuzzo, and the Ma_MISS team. Institute for Space Astrophysics and Planetology IAPS, National Institute of Astrophysics INAF, Rome, Italy (jeremy.brossier@inaf.it).

Introduction – Several regions located along circum-Chryse Planitia may indicate a long-lived aqueous history, where infrared data reveal extensive outcrops of recently exhumed clay-rich rocks [1]. These outcrops are appealing "*windows*" to seek signs of past or present life on Mars, as biosignatures might be preserved therein [2]. Here, we focus on clay-bearing outcrops identified in west Chryse Planitia (Fig. 1), particularly near Lunae Planum (304°E, 20°N) and Tempe Terra (310°E, 42°N). This investigation follows up recent analyses of clay-rich outcrops found in Oxia Planum [3,4] and north Xanthe Terra [5] (Fig. 1).

A detailed spectral analysis of these outcrops is crucial to determine possible mineral phase(s), and search for changes in clay mineralogies associated with differences in formation and weathering conditions. In this study, we investigate the spectral signatures of clay-bearing outcrops found in Lunae Planum and Tempe Terra. For doing this, we examine infrared data, notably the absorptions centered in the 1.0–2.6 µm spectral range, in order to better constrain the nature and composition of the clays.

Data & Methods – Spectral signatures of the clay-rich outcrops are obtained from the infrared data gathered by the CRISM instrument, with spatial resolutions of 20–40 m·px^{-1} and a spectral resolution of 6.6 nm [6]. Here, we use 14 CRISM cubes acquired in the near-infrared range (1–4 µm), targeting Lunae Planum and Tempe Terra. They are first pre-processed through CAT ENVI for atmospheric and photometric corrections. Corrected cubes are then denoised (column-by-column ratio) to reduce noise and residual atmospheric contributions, and to finally emphasize mineralogical absorptions in the ratioed spectrum. Once the cubes are corrected and denoised, we define our regions of interest (ROIs) to outline clays. We calculate band depths at 1.9 and 2.3 µm [7] to select pixels with strong absorptions and map the ROIs for each cube (Fig. 1).



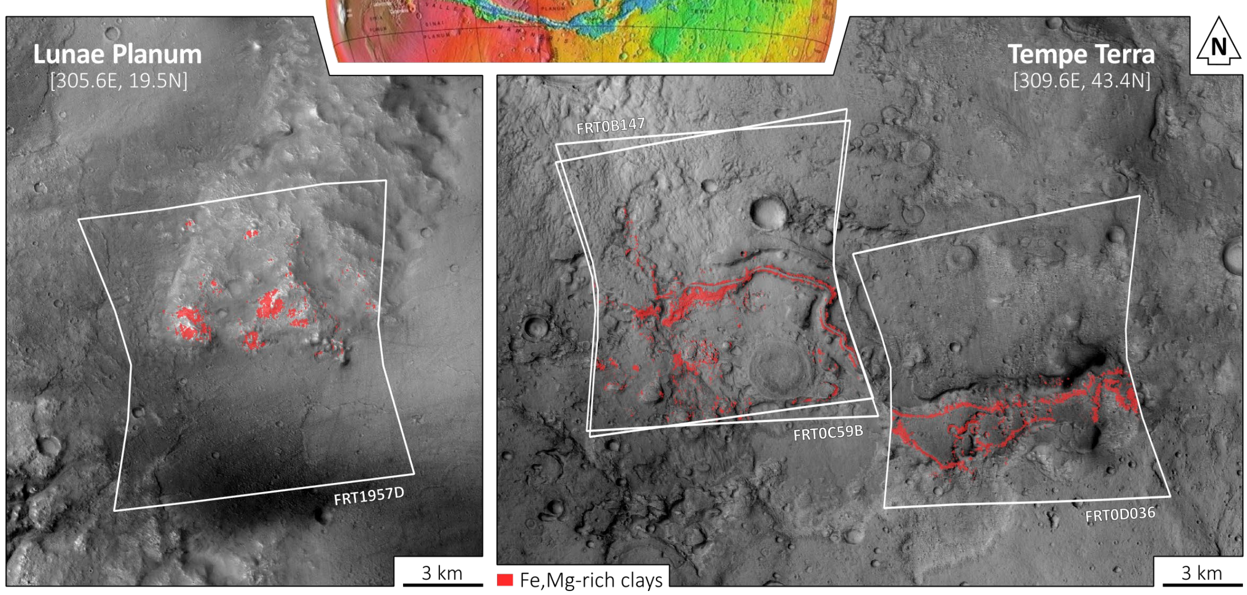


Figure 1 – (top) MOLA global topographic map with major regions in circum-Chryse Planitia: Oxia Planum (OP), Xanthe Terra (XT), Lunae Planum (LP) and Tempe Terra (TT). (bottom) Two sites of interest in CTX images, where the clay outcrops are mapped in red: (left) isolated hill (inselberg) in Lunae Planum and (right) sinuous ridges in Tempe Terra.

Results – For each cube, we retrieve the band centers for all pixels of the ROIs within the three spectral ranges of interest: 1.4 µm (1.37–1.45 µm), 2.3 µm (2.26–2.34 µm), and 2.4 µm (2.36–2.44 µm) (after continuum removal to emphasize the absorptions). For instance, the band centers do not strongly vary in the 2.3 µm window, with overall values spanning from 2.305 to 2.310 µm. Same procedure is used for the band centers near 1.4 and 2.4 µm, although both absorptions are weaker relative to the narrow absorptions near 1.9 and 2.3 µm. Band center varies between 1.402 and 1.408 µm in the 1.4 µm window, while it goes from 2.393 to 2.398 µm in the 2.4 µm window. Overall, these values are identical to those recently obtained at Oxia Planum and north Xanthe Terra [3–5].

Discussion – CRISM cubes reveal several absorptions in the 1.1–2.6 µm range (Fig. 2). Absorptions near 1.4 and 1.9 µm are common to hydrated minerals, while an absorption near 2.3 µm typically indicates a (Fe,Mg)-OH vibration. Clays found in Lunae Planum and Tempe Terra are consistent with Fe,Mg-rich clays, combining absorptions at 1.41, 1.92, 2.30–2.31 µm and weaker overtones near 2.39–2.40 µm. Martian Fe,Mg-rich clays generally show spectral variability in these three windows. For both regions, intermediate band centers are consistent with either vermiculites or Fe-rich saponites, as seen in Oxia Planum [3,4] and north Xanthe Terra [5]. Band centers within these windows vary little across the regions. Exact positions therein depend on the relative abundance of iron and magnesium in the clay structure, and the oxidation state of iron [8].

Conclusions – Here, we report a detailed spectral analysis of the infrared signatures from clay-bearing outcrops found in Lunae Planum and Tempe Terra, to complement previous studies dedicated to circum-Chryse Planitia [3–5]. We retrieved exact positions of the 1.4, 2.3 and 2.4 µm absorption bands, and also mapped the clearest clays within targeted areas, in context with the morphology and topography. Some clay outcrops are detected along inverted channels and small craters in Tempe Terra [9], whereas others are associated with isolated hills in Lunae Planum (Fig. 1). Nonetheless, additional investigation is required regarding the geologic setting(s) of these outcrops. This allows for further studies in context with the ExoMars rover mission and other missions in the future.

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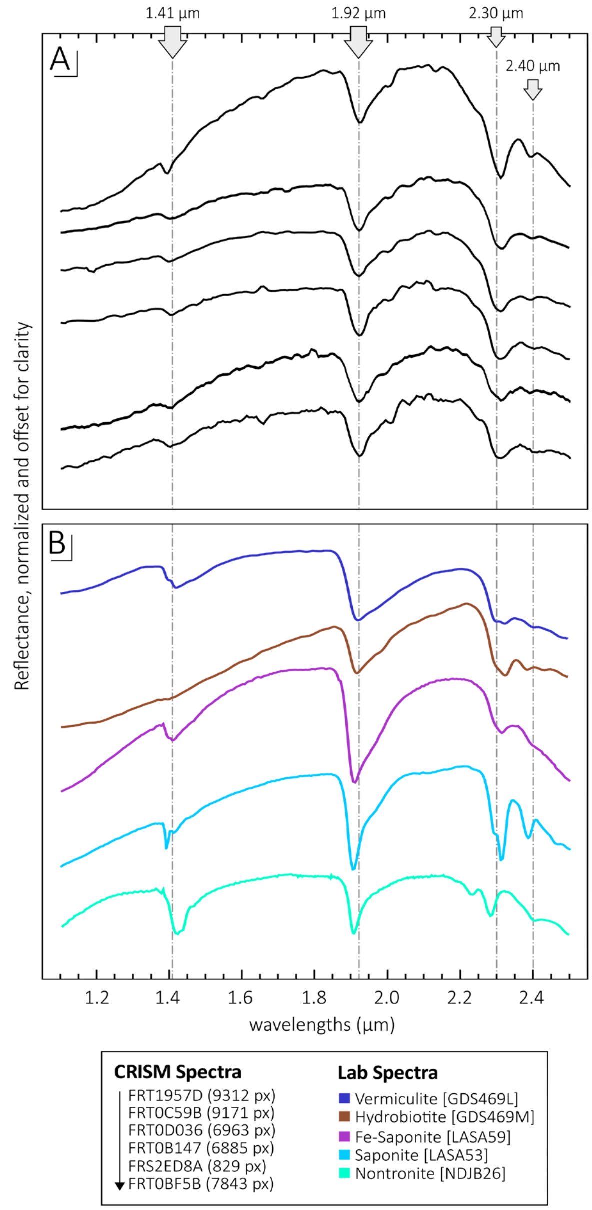

Figure 2 – (A) Denoised CRISM reflectance of clay-rich outcrops in west Chryse Planitia. (B) Lab spectra for comparison purposes.

References – [1] Carter et al. (2013) *JGR 118*, 831; Carter et al. (2015) *10th EPSC*, 661. [2] Vago et al. (2017) *Astrobiology 17*, 471. [3] Brossier et al. (2022) *Icarus 386*, 115114. [4] Mandon et al. (2021) *Astrobiology 21*, 464. [5] Brossier et al. (under review) *PSJ*. [6] Murchie et al. (2007) *JGR 112*, E05S03; Murchie et al. (2009) *JGR 114*, E00D07. [7] Viviano-Beck et al. (2014) *JGR 119*, 1403. [8] Michalski et al. (2015) *EPSL 427*, 215. [9] Pan et al. (2014) *8th International Conference on Mars*, 1273; Liu et al. (2021) *EPSL 562*, 116854.